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Evolutionary Acquisition of the Global Command and Control System: Lessons Learned

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PREFACE

This paper was prepared in support of IDA subtask "Global Command and Control System Lessons Learned." The primary task, "Evolutionary Acquisition Strategy and Planning," was sponsored by the Office of the Assistant Secretary of Defense for Command, Control, Computers, and Intelligence (OASD/C3I). Technical oversight for this study was carried out by Ms. Christine Condon of OASD/C3I.

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Finally, the authors note that the judgments expressed in this paper are their own and are not necessarily endorsed by IDA or the Department of Defense. Likewise, all errors in the paper are attributable only to the authors.

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EXECUTIVE SUMMARY

The communities responsible for developing, fielding, testing and operating the Global Command and Control System (GCCS) agree that an evolutionary acquisition approach is essential for exploiting fast-moving commercial technologies such as those underlying GCCS. The creation of the unique evolutionary approach utilized for GCCS began when the DISA-led development team initiated work in 1992. The GCCS community subsequently began developing a more formal management approach for GCCS in the Spring of 1996. This approach has been fleshed out and clarified in its applications to GCCS(Top Secret) released in the Summer of 1997, and GCCS(3.0) released in the Spring of 1998.

This paper summarizes a "lessons learned" study which reviewed DoD's approach to managing the GCCS program on behalf of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD/C3I). This study, conducted in the Fall/Winter of 1997/98, provides a brief history of the program, presents the views of the communities that develop, test, support, or use GCCS, and offers some specific lessons learned for continuing to strengthen the management of the program.

The GCCS community has made significant progress in the last two years toward establishing a management approach for evolutionary acquisition programs. Indeed, its innovations in the areas of requirements definition and modified development testing provide useful models for other programs. The community continues to develop and strengthen the management process, and important initiatives were begun during the course of this review. Not surprisingly, however, there is still a great deal of work remaining to be done. Lessons learned and remedial actions are summarized below.

Strategic Vision and Requirements

- A "*strategic vision*," with a three- to five-year horizon, is needed for PPBS, to sell/defend GCCS, to force long-term thinking, and to keep the community informed. Action: J3

- The *requirements process* has not been closely followed in the past, but will work through enforcement and institutionalization; a way to allow high-priority requirements to advance rapidly should be found. Action: J3, RWG. The *EPIP/RID* are not timely; recommend detaching the RID for early release and also releasing the EPIP earlier. Action: EPIP–D2, RID–J3

- *DARPA* initiatives should be better coordinated with the GCCS community to avoid unforeseen costs. Action: J3, RWG

Programming and Budgeting

- GCCS 3.0 should be declared the system *baseline* and a series of benchmarks should be developed to accurately capture performance and cost deltas. Action: D2, J3

Testing and Fielding

- Further *testing and evaluation* are necessary to verify the technical underpinnings of GCCS; user feedback should be increased; and procedures for evolutionary acquisition further developed. Action: D2, D6, OSD/DOT&E

- Migration of *JOPES* to GCCS was unsatisfactory and the projected gains in performance have not occurred; JOPES level 1 GSPRs should be fixed while efforts are focused upon the long-term solution of BPR. Action: D6, J3, J4

Operations and Support

- *Configuration management* needs to improve coordination between the field and headquarters while defining parameters to allow "hobby-shopping." Action: D6, J3

- The *PM's staff* should be augmented to alleviate current personnel shortages and to handle the expanded workload recommended by this study. Action: D2

- *Training* lags deployment considerably and current training efforts should extend beyond the classroom. Action: Services, DISA

EVOLUTIONARY ACQUISITION OF THE GLOBAL COMMAND AND CONTROL SYSTEM: LESSONS LEARNED

The developers of the Global Command and Control System have broken new ground in creating an evolutionary approach for acquiring defense information systems. In the fall of 1997, IDA was tasked by OSD/C3I to conduct a GCCS Management Lessons Learned Study in order to capture the initiatives taken within DoD since early 1995 to strengthen GCCS program management. The study is intended to identify the strong points in DoD's approach as well as to identify areas of continuing weakness in practices and procedures. In summation, the study was asked to address the question: *Which GCCS management practices and process work well, which don't, and what, if anything, should be changed?*

Several factors motivated this review, including increased interest from non-DoD parties, e.g., the General Accounting Office, as the program grows in both cost and scope; the desire to document lessons learned as the first generation of personnel involved with the program departs; the need to conduct the necessary periodic management review that all programs are subject to; and to see if a general model could be distilled for use in other similar programs. Initial results were briefed to OSD/C3I in December 1997.

This paper summarizes the approach and findings of the lessons learned review. Section A describes the study approach, and the fact-finding the provides the basis for the findings. Section B provides a brief history of the GCCS program, highlighting the key activities and events relating to the management of the program. Section C describes the perspectives of the main communities involved in the development, fielding, and operations of the system. Section D highlights several specific lessons learned from this review. These lessons suggest an agenda to strengthen the management of GCCS, and to develop a general model for evolutionary acquisition that can be applied to other similar programs. Some concluding comments are presented in Section E.

A. APPROACH

The fact-finding in this study was primarily accomplished through a series of interviews conducted over a four-month period, beginning in September 1997 and continuing through January 1998. A total of 55 individuals were interviewed (see the Annex to this document for a complete listing), representing the CINCS, the Component Commands, DISA, the Joint Staff, OSD, and the Services. On-site visits to the Commands

were conducted at ACC, ACOM, CENTCOM, and TRANSCOM. A small number of telephone interviews were also conducted to gain the perspectives of officials in EUCOM, FORSCOM, PACOM, and USFK. The remainder of the interviews were done in the Washington D.C. metropolitan area.

Individuals interviewed were selected for their experience, their position, or at the recommendation of other interviewees. A rough balance was sought in canvassing each of the segments within the GCCS community, and at each of the Commands visited. The interviews typically comprised two interviewers and one interviewee, although the precise numbers varied in a few cases. Each interview lasted 30-60 minutes, depending upon scheduling and the amount of material to cover. When visiting a site, as many as five or six interviews were accomplished in the span of a single day.

Subject matter was tailored to take advantage of the experience and perspective of each interviewee. Questions addressed management-level issues, emphasizing current and future concerns, although historical perspectives were also valued. Sample questions might include: How is training done for GCCS; is it done well; are some segments done more effectively than others; what are the shortfalls; is the training situation improving or worsening; and what, if anything, should be changed.

In addition to these interviews, a number of documents were reviewed, including both the GCCS(Top Secret) and the GCCS(3.0) EPIPs; several cables and briefings describing a summer 1997 functional assessment of GCCS conducted by EUCOM;[1] minutes collected from a number of meetings; Executive and Congressional laws, regulations, and reports, e.g., the Clinger-Cohen Act[2] and a GAO report on performance measures;[3] and assorted other documents[4], including a training CD-ROM[5] and briefings delivered by various segments of the GCCS community at a Spring 1997 AFCEA course

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[1] Cable from U.S. European Command to the Joint Staff and DISA, Subject: Global Command and Control System (GCCS) European Command Functional Assessment, DTG 031715Z November 1997, classified SECRET. See also *U.S. European Command July 1997 USEUCOM GCCS Functional Assessment* brief, IDA log number E 98-000256, classified SECRET. See also *EUCOM THEATER Global Command & Control System (GCCS) User Survey* blank form, uncontrolled document, also available at IDA.

[2] Also called the Information Technology and Management Reform Act of 1996.

[3] *Measuring Performance and Demonstrating Results of Information Technology Investments*, General Accounting Office, GAO/AIMD-97-163, Exposure Draft, September 1997.

[4] Especially CJCSI 6721.01, *Global Command and Control Management Structure*, 18 February 1995.

[5] GTN EWEB Tutorials, USTRANSCOM J3 - JOPES Training Organization, CD-ROM for Microsoft Windows, July 30, 1997.

on the topic. These data were collected and evaluated to augment the opinions solicited by the interviewers and the judgment of the interviewers themselves.

B. A BRIEF HISTORY OF GCCS

To provide a context for the observations and lessons learned detailed in subsequent sections, this section provides a brief overview of GCCS. It traces the birth of GCCS from WWMCCS in 1992, its August 1996 fielding, and its subsequent evolution up to early 1998. Emphasis is placed upon the role of acquisition reform.

1. WWMCCS and the Origins of GCCS

The Worldwide Military Command and Control System (WWMCCS) was a mainframe-based, Honeywell system first designed in the 1960's to provide automation support for deliberate planning and secure messaging among the major warfighting Commands. WWMCCS ran in a Top Secret environment, so terminals were typically located in vaults or other highly secured installations, and were not widely available to staff in Command centers. WWMCCS was maintained by dedicated administrators; over the years there emerged a cadre of users supporting both deliberate planning and crisis action planning, as well as deployment planning.

As technology advanced and the potential to exploit automation grew, upgrades to WWMCCS were attempted under the WIS and WAM programs. These programs spanned from the early 1980's until late 1992. Despite attempts to upgrade WWMCCS, its capabilities remained limited, and access to the system was restricted by its high level of classification. In addition, there were growing concerns that the expenses of the various upgrades were not justified by the capabilities gained.

A major review conducted in June 1992 by a C4I Interoperability Tiger Team found that WWMCCS was deficient in meeting warfighter requirements. Deficiencies resulted from problems in the user's ability to enter and access information; a lack of software flexibility to modification; an unresponsive, inflexible, and expensive system architecture; a lack of interoperability with other command and control (C2) systems; the high cost of maintaining below-Top Secret data (which constituted the bulk of WWMCCS data) on a Top Secret system; the inability of doctrinal, operational, organizational, training, or material alternatives to remedy these deficiencies; and the perception that

mainframe computing was outmoded.[6] After years of investment and user disappointment, WWMCCS had effectively reached a dead end. A replacement system was needed.

In December 1992, funding for WWMCCS modernization and improvement was terminated; this funding was redirected to develop and field a WWMCCS follow-on program, GCCS. In contrast to WWMCCS, GCCS was to be a commercially based system in a client-server environment. It would operate on the DoD's classified version of the Internet (SIPRNET), and therefore provide secure access to a much wider range of users. This approach emphasized linking C2 systems together to allow unencumbered data exchange, immediate and nearly equal access to data among a much broader circle of users, increased interconnectivity, low cost, a graphical user interface, frequent and rapid upgrades, and evolution over revolution in acquisition. Essentially, GCCS was intended to emulate trends already under way in corporate America.

Development of GCCS was accomplished through a partnership of the Defense Information Systems Agency (DISA), the Joint Staff, and the Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD/C3I). Deemed an evolutionary acquisition program in the GCCS migration strategy, the program was not subject to oversight by the Major Automated Information Systems Review Council (MAISRC) until August 1994. This decision was due in part to the perception that MAISRC acquisition procedures were cumbersome and time consuming, and would only serve as a stumbling block to the flexible and rapid development of GCCS.

2. The Evolution of GCCS

In August 1996, GCCS(2.1)[7] was fielded and declared the "System of Record" (SoR).[8] The majority of WWMCCS was concurrently shut down, although a small portion remained in operation until GCCS(Top Secret) was declared SoR in July 1997. It is envisioned that eventually multi-level security will allow the two separate GCCS systems to combine as one, but until then, the much larger GCCS Secret-high system will remain discreet to facilitate ease of use and to minimize cost.

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[6] For a more lengthy discussion of these deficiencies and a then contemporary view of GCCS, see *Validation Approval of Mission Need Statement (MNS) for Global Command and Control System (GCCS)*, Joint Staff, 8 June 1995.

[7] Earlier versions, GCCS(1.0) and GCCS(1.1), were deemed not ready for fielding.

[8] System of Record (SoR) is a new term designed to avoid the administrative entanglements associated with Initial Operating Capability (IOC).

The fielding of GCCS(2.1) was a difficult process, hampered by insufficient developmental and operational testing, untrained users, poor or missing documentation, and a variety of technical glitches. Numerous GSPRs (GCCS Software Problem Report) were filed. Some were addressed in GCCS(2.2.x), but many were never fixed in the hope that the follow-on, GCCS(3.0), would solve them.

This next main version to be fielded was GCCS(Top Secret) in July 1997. GCCS(Top Secret) essentially provided GCCS(2.1) capabilities to a much smaller group of users on a Top Secret network. It did not present the same degree of difficulty as GCCS(2.1), but nonetheless many problems remained, e.g., management of double encryption over the SIPRNET. GCCS(Top Secret) was the first version of GCCS for which the evolutionary acquisition process was employed and for which an EPIP was developed.[9]

The next iteration of the GCCS Secret-high system is GCCS(3.0), which is in the process of fielding as this document is being written (winter 1998). The fielding process has changed significantly as the result of the GCCS(2.1) experience. Specifically, more thorough testing was done, including Modified Development Testing (MDT), which brought the testers out into the field to address site unique conditions, while the users saw this as an opportunity to learn and express their needs directly to the developer. Documentation has improved and training is less a problem as users now have 18 months experience using GCCS. Nonetheless, it remains to be seen how successful fielding will be. An EPIP was written for GCCS(3.0).[10]

Capabilities and features of GCCS(3.0) include the Common Operational Picture (COP), the Joint Operations Planning and Execution System (JOPES), the air-tasking order, weather data, intelligence imagery, ballistic missile defense, web pages, chat groups, e-mail, and many other salient applications. All GCCS(3.0) applications are designed to comply with the standards set by the DIICOE (Defense Information Infrastructure Common Operating Environment). This represents a major difference between GCCS(2.x) and GCCS(3.0), as it will allow many more applications to be efficiently linked, whereas GCCS(2.1) was essentially a migration from the mainframe environment to the client-

[9] *Global Command and Control System - "Top Secret" GCCS(T), Evolutionary Phase Implementation Plan, Phase I*, no author listed, December 1996. Note: this document is often attached under the cover of the *Requirements Implementation Document*, citation otherwise the same except for the Joint Staff as author.

[10] *Global Command and Control System (GCCS) Requirements Implementation Document (RID) and Evolutionary Phased Implementation Plan (EPIP) Phase II, GCCS Version 3.0*, Defense Information Systems Agency, Joint Interoperability and Engineering Organization, 24 October 1997.

server environment. In addition, it allows operating system and database management system upgrade to more current and widely supported software.

3. The GCCS Development Strategy

Another perspective that helps in understanding what was attempted with GCCS, and to evaluate what was accomplished, is to view its history in terms of the developers' underlying strategy. This strategy focused on three main objectives. The first was to establish the backbone of a client-server information system using the SIPRNET to link key C2 centers. The second was to establish and maintain seamless interoperability and supportability of C2 functions among these centers, so that important planning and operational functions and data could be used commonly across the network. The third was to establish an evolutionary acquisition approach that would develop, test, and field manageable increments of GCCS. This approach would allow DoD to expand C2 capabilities by incrementally expanding the scope, functional utility, and speed of command and control functions. Although significant challenges remain, this three-part strategy has proven to be largely successful.

a. SIPRNET backbone

GCCS clearly has succeeded in meeting its first goal of exploiting SIPRNET to establish connectivity among headquarters and Commands. DISA accomplished this, in part, by taking the lead in buying the equipment needed to establish the backbone of the system at 39 key headquarters and field Commands and 15 database sites. This helped ensure that the key headquarters and Commands became users of the system. Following this lead, connectivity has been established at hundreds of additional sites. SIPRNET connectivity supports web technology such as e-mail, web pages, newsgroups, and chat rooms, and has provided significant advances in the capability of Commands and headquarters to exchange information.

The contribution of these SIPRNET connectivity functions to C2 deserves emphasis. Although GCCS expanded the availability and scope of C2 capabilities well beyond those available with WWMCCS, there still was a tendency in the early stages of fielding GCCS to judge it primarily in comparison with the JOPES functions that had been provided by WWMCCS. This perspective was the result of a user community that stressed the transition of WWMCCS functions over the addition of new functionality. The resulting bias, combined with the lack of a user-validated requirements document, led the OT&E community to test primarily for WWMCCS functionality, e.g., JOPES, GSORTS, JMAS,

etc., in GCCS. Since it is unrealistic to expect a new system to uniformly outperform a mature system of 25 years, JOPES shortfalls by WWMCCS standards were reported.

Consequently, the persistent problems with JOPES automation, particularly in supporting crisis action planning (which in some cases were aggravated by the transition to GCCS) became the focal point for judging GCCS. This perspective created an unfair portrait of GCCS, because the complaints about JOPES overshadowed the other contributions of GCCS through increased connectivity and situational awareness. The community now takes a more balanced view of GCCS. Indeed, even JOPES users that remain disappointed with JOPES performance agree that GCCS has improved C2.

b. interoperability and supportability

The second broad goal of the GCCS acquisition strategy is to achieve global interoperability of C2 functions across headquarters and field Commands. The WWMCCS centralized mainframe computing environment ensured interoperability for the limited functions it supported, since the mainframe environment naturally imposed standardization. In non-WWMCCS C2 functional areas, however, the field Commands and Services built unique architectures, which provided little or no interoperability.

Accomplishing and maintaining interoperability across the Commands and Services will require balancing the field commanders' prerogatives to modify or build new C2 applications against the benefits of a common framework that provides interoperability. GCCS developers have adopted a two-pronged approach to achieve this.

The first is to promote standardization within GCCS. The developers have established standards for hardware and software that are intended to guarantee interoperability. The centerpiece is the adoption of the Defense Information Infrastructure Common Operating Environment (DII-COE). The theory is that using standard hardware and software, along with common databases, will facilitate interoperability within the GCCS user community.

The second prong of the approach was not just to standardize within GCCS, but to actually make GCCS the "standard." Much as Microsoft Windows is the standard operating system for desktop computing, DISA sought to make GCCS the standard C2 system for the purpose of further easing interoperability and supportability. In addition to funding the fielding of a system backbone, this was accomplished by incorporating functions in high demand by users into the COE, which resulted in increasing GCCS' "market share" of C2 systems.

c. evolutionary acquisition

The third major objective of the GCCS strategy was to establish an evolutionary approach for expanding GCCS functions. Initially this was devoid of many of the traditional aspects of an acquisition program, e.g., documentation, management structure, etc. And in many respects, the early days of the GCCS development activity could be described as a "skunkworks" operation. While GCCS developers maintained close contact with the most senior leaders in ASD(C3I), DISA, and the Joint Staff, they did not interact extensively with the communities responsible for programming and budgeting, testing, fielding, or operations and support. This approach enabled the developers to focus on the technological tasks at hand, and it possibly contributed to the speed, and perhaps the viability, of the development.[11] The downside of this approach, however, is that—in retrospect, at least—many challenges involved in fielding the system were not anticipated and thus were not prepared for. Poor preparation by the development community (e.g., DISA) led to difficulties testing and fielding, and many Commands were forced into months of catch-up in establishing capable, trained operators and system administrators.

In reaction to this atypical pattern of developing and acquiring a major computer system, the Office of the Inspector General (IG) audited the management of GCCS and issued a report in May 1995 critical of several aspects of the program.[12] The IG recommended that GCCS be designated a formal acquisition program with centralized management and be subject to the MAISRC process, that the system be baselined, and that a number of acquisition and management documents be written, including a Mission Needs Statement, an Operational Requirements Document, an Acquisition Strategy and Plan, a Test and Evaluation Master Plan, and an Integrated Logistical Support Plan (ILSP). The audit also noted that testing was inadequate. DISA, the Joint Staff, and OSD concurred with all twelve suggestions.

Following the IG report, OSD undertook to develop a more formal acquisition strategy for GCCS while preserving the principles of streamlined, evolutionary acquisition. In order to help develop this new acquisition strategy, an informal Working Group on Evolutionary Acquisition was established in March of 1996. This group included the key working-level players in the GCCS community from DISA, the Joint Staff, the Services,

[11] The factors which led to GCCS development are threefold: technology which allowed for a successful client-server environment; declining budgets which forced cooperation and a turning away from expensive stovepipe systems; and the force of personality embodied by RADM John Gauss who led the development of the GCCS.

[12] Department of Defense, Office of the Inspector General, *Audit Report on Management of the Global Command and Control System*, Report No. 95-201, May 24, 1995.

and OSD. After extensive deliberations, in the Summer of 1996 the group agreed upon an evolutionary acquisition approach.[13] This approach meets the concerns of the IG Report, while retaining the flexibility needed to rapidly field new capabilities. Although too late to have significant impact upon the August 1996 fielding of GCCS(2.1), the process was partially applied to the next iteration of GCCS, the GCCS(Top Secret) system fielded in the summer of 1997. The new approach is also being used in the fielding of GCCS(3.0), which is expected to be fielded in the Spring of 1998.

A major element of this new acquisition strategy is the Evolutionary Phase Implementation Plan (EPIP). The EPIP is essentially a contract among the major components of the GCCS community. It contains a Requirements Implementation Document (RID), a functional description, information on the system architecture, concepts of operation for security, testing, training, and production operations, as well as an ILSP, costing data, and a risk assessment chapter. The EPIP is authored by DISA with Joint Staff assistance. The document is jointly coordinated by the Commands and MAISRC principals and approved by the ASD/C3I, the J3, and DISA. The EPIP contains much of the same information required under the MAISRC process of project documentation, but is significantly more integrated, timely, and streamlined. The EPIP is an unclassified document distributed widely among the Department, to include the Commands and Services.

A second significant outcome of the new acquisition strategy was the formulation of a requirements process. Up to that point, the requirements process had been *ad hoc* and subjective rather than a formal assessment of cost, risk, and prioritization. The new requirements process was, in its essence, a fairly typical one. It required that the customer's demands (i.e., CINCS) be weighed in terms of cost, risk, and priority by a requirements working group and in several assess phases led by the Joint Staff and DISA. Despite being formulated in 1996, the requirements process was applied to neither GCCS(Top Secret) nor GCCS(3.0). It is expected that all further iterations of GCCS will be subject to the requirements process.

A key product of the requirements process is the Requirements Identification Document (RID), which describes the functions that will be added in an upcoming development phase. The RID is intended to provide an early overview of the development

[13] A description of this approach may be found in *An Evolutionary Acquisition Strategy for the Global Command and Control System (GCCS)*. Richard H. White, David R. Graham, and Johnathan A. Wallis, Institute for Defense Analyses, IDA Paper P-3315, September 1997.

activities to be pursued in an implementation phase, and gives advance notice to testers and field personnel of the GCCS functions that will be added in the coming months.

C. COMMUNITY VIEWS

The GCCS community is, in fact, a collection of different communities, each with its own view and understanding of GCCS. This collective may be roughly divided into six sub-communities: testing and evaluation; development; the Commands; the Joint Staff; budgeting; and oversight. The following descriptions of each community's views are fundamentally composite sketches which portray their general outlook and concerns. Specific management issues will be addressed later in the paper.

1. Testing and evaluation

The GCCS community was initially distraught over the fielding of GCCS, especially versions prior to and including GCCS(2.1). Many outside the development community, particularly operational testers, were frustrated by the resistance of developers to thoroughly test GCCS. And the Testing and Evaluation (T&E) community itself was unsure what to test, given the amorphous nature of the system and unclear user requirements, resulting in too much emphasis upon JOPES at the expense of other applications. The T&E community perceived that its role as the technical guarantor of the system was greatly undermined in the rush to field these versions.[14] The IG report, for example, noted that GCCS versions 1.0 and 1.1 had not been subjected to adequate developmental or formal operational testing and evaluation prior to fielding. Likewise, GCCS(2.1) had not been not adequately tested at the developmental stage. This resulted in a "disastrous" fielding experience, which created hard feelings that still persist today in various segments of the community.

The GCCS community has worked hard to improve T&E. One important innovation is Modified Development Testing (MDT). MDT provides a phased approach to developmental testing and focuses on early field feedback rather than simply delivering the "next great thing" to an unsuspecting user. (For example, in late 1997 the final phase of MDT testing for GCCS(3.0) took the release out of the lab for early testing at a number of sites.) In parallel, a recognition is developing within among the T&E community that it must continue to adapt to the nature of evolutionary acquisition, for example, by testing only the deltas of the latest software release, as opposed to testing the entire system with

[14] It should be noted that testing now supports a decision by the user to field, and not the acquisition community.

each new release. In addition, the overall community is motivated to not repeat the early difficulties in fielding GCCS and is increasingly cognizant of T&E as an enabler, and not a roadblock to development. Finally, testing now supports a user decision to field and not an acquisition decision.

Key operational tests, such as the robustness of the system under wartime stresses, remain to be conducted. Entry and exit criteria are still felt to be absent, or ignored.[15] And questions concerning the long-term nature of the system must be answered. For example, some underlying issues in the shift from a mainframe to a client-server architecture have not yet been validated by the T&E community.

2. Development

The development community was a driving force behind the conception, development, and early fielding of GCCS. Not surprisingly, this community is inclined to view GCCS in technical terms. It is proud of the rapid development processes achieved in the fielding of GCCS. From the first concept of GCCS in 1992, the community developed and fielded GCCS as the system of record in under four years, with more than 500 user sites. Many of the highly valued network service features described earlier have been available since early 1995. Developers believe they have succeeded in establishing the basic foundation of platforms, network interfaces, databases, and applications needed to revolutionize command and control.

3. Commands

The Commands are generally supportive of GCCS and are especially happy with the increased interconnectivity among users via web pages, chat groups, email, etc. Usage of the Common Operational Picture (COP) varies, but heavy users, such as CENTCOM and USFK, are strong backers of this application. The Joint Operation Planning and Execution System (JOPES) performs satisfactorily at some Commands, but heavy users, such as ACOM, FORSCOM, and TRANSCOM, are dissatisfied with the speed and database synchronization of the system. Major concerns expressed by the Commands include a still lagging training program, high staff turnover, the limited deployability of GCCS to a JTF, and the user's influence on development priorities. The Commands were displeased with the fielding experience of GCCS(2.1) and have welcomed subsequent steps to correct for this with GCCS(3.0). They are quite pleased with MDT, better

[15] The February 1998 decision to postpone SoR on GCCS(3.0), due in part to security concerns, represents a positive step by the users in reaffirming the role of entry/exit criteria.

software documentation, and the increased responsiveness of GCCS developers to their needs.

4. Joint Staff

The Joint Staff is a strong proponent for GCCS. Despite the difficulties in fielding GCCS, the Joint Staff believes GCCS has significantly improved command and control. It believes that the program has worked relatively well, and that critics are often unduly faultfinding. The Joint Staff is nevertheless committed to continually improving the management of the program. It collectively feels that many improvements have not been properly credited by critics, possibly as a result of the informal processes by which they were made.

The Joint Staff has made significant strides in implementing a systematic requirements documentation and validation process. In 1996, it initiated the development of the GCCS Requirements Identification Database (GRiD), and performed a systematic survey of the Commands to identify their priority requirements. GRiD thus provides a repository of the CINCs' desired future capabilities, and a starting point for developing a GCCS roadmap. In the Fall of 1997, the Joint Staff initiated the first set of assessments of pending requirements to provide a basis for the Review Board and Advisory Board to recommend priorities for development activities beyond GCCS(3.0).

Several other Joint Staff initiatives are under way to further strengthen management of the program. These include developing performance metrics–both system and functional–to aid in development of a baseline; addressing training issues; and developing a roadmap for GCCS.

5. Budgeting

The budgeting community naturally focuses on costs, and has repeatedly expressed concern about the apparent inability to predict the budget requirements for GCCS. The budget community must contend with the Department's financial management system–PPBS (Planning, Programming, and Budgeting System)–which traditionally has required detailed five or six year program projections for funding, activities, and products. Thus the budget community is caught between the needs of the PPBS process and the desire to maintain flexibility in managing the GCCS development activities. Budgeteers have had difficulty developing cost figures for several reasons, including the rapidly changing nature of the program; the lack of a clear vision; blurred boundaries as

Information Technology (IT) programs and infrastructure merge; and the lack of a program baseline in GCCS.

They also have legitimate concerns over Operation and Maintenance (O&M) costs. These are ill-defined, and believed to be huge, hidden, and growing, e.g., support, training. Some in the budget community believe that these hidden costs represent a potential landmine for the program. Solutions to these problems have been offered, but most go significantly beyond GCCS, since the problems stem from the manner in which DoD manages IT department-wide, rather than having their specific roots in GCCS.

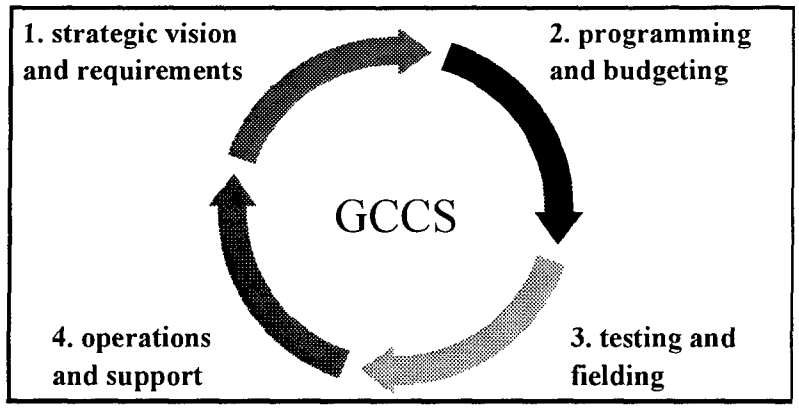
6. Oversight

The oversight community (OSD/C3I) is generally pleased with the progress made since early 1996 in managing GCCS. They observe a great deal more communication within the GCCS community. The oversight community attributes this in part to the requirement to develop an EPIP for each major new release. The process for preparing each EPIP has forced the community to address many issues, and therefore reduces surprises and over-inflated expectations. The oversight community also believes that the new testing practices represent a significant improvement. The community nonetheless professes many of the same concerns as the budget community, particularly the potential hidden costs of the system. It also must concern itself with maintaining sound relations with Congress and its watchdog, the General Accounting Office. Specific worries include the continued need to establish a program baseline as required by the Clinger-Cohen Act, and difficulty in costing the program, another area of keen Congressional interest.

D. LESSONS LEARNED

The lessons learned from the community's past experiences with GCCS and evolutionary acquisition suggest a number of ways to improve future management of the program. Not all of these lessons learned result in policy prescriptions, since some are already being addressed or may be characterized more as observations. Other lessons learned, however, provide insight into not only GCCS but also for all programs utilizing evolutionary acquisition. The section is divided into four parts (Figure 1), which loosely trace the process from idea generation, through the PPB process, testing and fielding, and finally to the operations necessary to support the fielded system.

Figure 1. GCCS Lessons Learned Organization



1. Strategic Vision and Requirements

Lesson 1: The GCCS community needs a strategic planning process that would develop a three- to five-year roadmap showing how GCCS links to JV2010.

One common desire expressed by the GCCS community is the need for a strategic vision, or a roadmap, to connect implementation documents such as the EPIP to vision statements such as Joint Vision 2010. The reasons behind this are manifold, including the need to link upgrades of equipment, license purchases, and training to some overall plan. Similarly, officials responsible for programming and budgeting could better anticipate programmatic needs if a general roadmap were available. In addition, some of the community's coordination problems with DARPA (see *Lesson 7*) could be eased by including a section discussing projected technologies and applications that might affect GCCS. Finally, a roadmap would aid in keeping the community informed, would develop a common vision of the future, and would aid in selling/defending the program to those outside the community.

The roadmap would include a three- to five-year projection of GCCS functions, concepts of operations, performance, users, and architectures. It would be a brief annual document intended to inform the community of the leadership's intentions. This process is essential for setting the future course for GCCS, and for building the bridge that ensures GCCS mid-term development activities support the long-range objectives suggested in JV2010. It differs from an Operational Requirements Document (ORD) in that it is not a binding document containing contractual performance goals, but a more informal, and hence flexible, document that provides guidance without becoming a dated straitjacket.

The roadmap should be relatively general, while addressing the full range of system development, testing, fielding, and operations and support issues. Topics to be addressed would likely include, but not be limited to:

- future capabilities
- depth of fielding
- system architecture
- interoperability
- refresh cycles
- future of DIICOE
- security
- operations and support
- related development activities
- C2 vs. fire control functions
- concepts of operations
- future of SIPRNET/DISN

The roadmap would provide a strategic front-end for the Joint Staff's requirements process, and thus should be prepared for the GCC Review Board, chaired by the Vice-Director J6.

Lesson 2: The requirements process needs to be strengthened and enforced. The EPIP and the RID need to be made more timely.

The GCCS requirements process was outlined relatively late in the program (early 1996) in response to planning uncertainties inherent in the absence of a requirements process. One difficulty that has subsequently arisen is between a CINC's "fast-track" requirements and the legal inability of the Joint Staff to force the CINC to comply with the vetting necessary in the more lengthy and formalized requirements process.

One key aspect of the GCCS requirements process is that it has been very responsive to CINC demands. Those CINCs who have chosen to weigh in typically have gotten their high-priority applications fielded through what has been called a "fast-track" fielding process. Typically, these CINC requirements stem from experimental applications, such as developed under DARPA ACTD programs for a CINC, e.g., DART, or from pre-existing commercial (COTS) or government (GOTS) applications. The responsiveness of the process to the CINC's requirement is a clear advantage to the user.

Unfortunately, this "fast-track" approach also has had a cost. Until recently, the process typically had not provided for the systematic review of requirements. Great emphasis was placed on fielding the new applications desired by the CINCs, and, in the view of many, too little emphasis had been given to the requirement to improve the quality

of existing applications. Testers, Service programming and budgeting officials, and many in the field Commands expressed concern that this approach led to an imbalance in the fielding of new applications versus improving existing applications. This approach also surprises personnel responsible for funding, training, and support of these applications, and undermines the orderly testing of new applications.

The Joint Staff has begun addressing this issue through its existing requirements process. For example, in establishing requirements for Phase II of GCCS(3.0), the Joint Staff approved some "fast-track" fielding proposals but also decided, for the first time, to delay the fielding of other proposed "fast-track" requirements. As the Joint Staff continues to develop the GRiD and assessment process, and to enforce its requirements process, it should increasingly be able to assess and decide on such "fast-track" proposals.

The Joint Staff's ability to handle "fast-track" requirements will be significantly strengthened by establishing a GCCS programmatic roadmap along the lines outlined in the preceding section. The roadmap should reduce surprises, because it will provide a survey of ACTDs and other experiments or development activities that could generate requirements. These then could be folded into the Joint Staff's requirements assessment process, along with requirements entering through the formal requirements process. In combination, the roadmap and strengthened Joint Staff requirements process provide the mechanisms needed to address the problems that have been raised in the past with decision making associated with "fast-track" fielding. Clearly, this system can and should accommodate "fast tracking," but it should be done using a structured decision-making process that weighs the costs and benefits of each idea.

A second part to this lesson concerns the Evolutionary Phase Implementation Plan. The EPIP provides a contract among the developers, overseers, testers, and users, defining the goals and plans for each phase of acquisition. It initially was intended that the EPIP would be published at the outset of each phase and used as a decision-making document. Instead, the EPIP has been issued near the end of the development phase, shortly before the onset of testing and fielding. The EPIP is best described as a compilation of decisions that have already been made, as opposed to a decision document itself.

Nevertheless, many interviewees have observed that the process for developing the EPIP has proven to be more valuable than the document itself, because it has promoted communication across the involved communities, and has contributed to the resolution of numerous issues. Beyond this, it serves as a significant and valuable source of information,

especially for the field Commands absent from the day-to-day decision-making in Washington.

The EPIP itself provides a good description of program changes, and it generally answers the key questions concerning what is to be done, when is it to be done, who is responsible, and what resources are needed. The document does have flaws, however. Gaps in coverage include incomplete assignment of responsibilities; insufficient coverage of O&S costs; too many placeholders, e.g., the TEMP; and a number of other issues that require attention, although a roadmap (see *Lesson 1*) would address a large number of these. Future versions of the EPIP should be simplified by reducing the amount of extraneous data present.

The Requirements Implementation Document draws on requirements from the GRiD database that form the basis for the EPIP. Since requirements are known substantially in advance of the many other types of information contained in the EPIP, these should be detached and published as early as possible to allow the community to react. Secondly, the EPIP should be pushed up in advance. Although it is unlikely that it will ever be used as a decision-making document (this will happen instead in the Assess phase of the requirements process), it will allow the community to better prepare for the next release of GCCS; e.g., the training program could be developed before the version is released.

Lesson 3: DARPA needs to be better coordinated with the GCCS community.

One repeated concern expressed by the GCCS community, and the Services in particular, has been the lack of coordination between the community and the Defense Advanced Research Projects Agency (DARPA).[16] DARPA initiatives, while useful and innovative, often arrive with little forewarning. As a result, when DARPA-authored software is added to the GCCS build at the request of a sponsoring CINC, the Services, who fund most of GCCS, are often caught short financially. In addition, DARPA does not consider the support required by the software, e.g., training, which represents a further burden for the Services beyond paying for the software.

Two potential solutions exist to strengthen coordination between the GCCS community and DARPA. The first is to have DARPA brief, on a quarterly basis, the

[16] DARPA is chartered as a research agency and should not be building software applications for the field. Regardless of this apparent breach of the charter, it would be foolish for the GCCS community to discard DARPA's valuable contributions to GCCS based on a theoretical notion of how the Agency should operate.

GCCS Requirements Working Group. The second solution is to incorporate a section into the Strategic Vision (see *Lesson 1*) that covers a number of future technologies or studies that may affect GCCS. In addition, the Strategic Vision may aid DARPA in understanding what types of technology would be most useful to the GCCS community, and thus allow them to channel their efforts versus the current undirected studies.

2. Programming and Budgeting

Lesson 4: GCCS(3.0) needs to be baselined in order to develop system, functional, cost, and measurement.

GCCS does not have a baseline. A baseline provides a snapshot of a program in terms of performance and cost, and allows any changes against this baseline to be measured. A baseline is needed for several reasons, including compliance with the Clinger-Cohen Act, the ability to develop performance and cost metrics, and simple program management. The Clinger-Cohen Act of 1996 requires that a baseline be established in order measure the difference that any changes to the system would make and whether or not those changes are justified, based on a cost/benefit analysis.

The Joint Staff is currently in the process of establishing a baseline for GCCS. This initial effort is looking primarily at system (e.g., how fast does GCCS process) and functional (e.g., how fast can I do this task on GCCS) baselining. Eventually, all aspects of the program should be baselined, including technical and architectural baselines, a cost baseline, etc.

There has been general agreement across the community that GCCS(3.0) will be the system baseline against which changes will be measured.

3. Testing and Fielding

Lesson 5: Testing needs to continue to adapt to evolutionary acquisition. The GCCS testing approach needs to be codified in a "capstone" Test and Evaluation Master Plan.

As described earlier, the views of testers and developers have evolved as they have learned that significant issues can arise in fielding new versions of GCCS that simply could not be identified in laboratory testing. These result from many factors, including the interaction of GCCS software with both local and wide area networks, or with local UNIX configurations. It is now generally accepted that field testing is needed before entering final operational testing. As a result, the community has developed the concept of "Modified Development Testing" for GCCS(3.0). MDT entails a phased sequence of

contractor, DISA integration laboratory, and field tests at operational sites. It thus incorporates field testing as part of the development testing process.

MDT has received significant praise throughout the GCCS community. This approach has increased confidence that GCCS(3.0) can be installed and operated successfully in the field. This approach should also reduce operational testing problems, and has provided the field activities with a preview of the applications, which will contribute to improvements in training, operations, and support.

The MDT process for GCCS(3.0) has not been perfect. Commands using Hewlett-Packard hardware experienced significant delays in installing the software. Other Commands experienced database problems, and were unable to perform many of the tests. And in every case, the tests were performed on discrete test networks, which may not reveal some of the software-network interaction problems that plagued earlier versions when they were fielded.

There is general agreement that a "capstone" Test and Evaluation Master Plan (TEMP) is needed to lay out the strategy and approach for GCCS testing. This plan can describe modified development testing and also how performance requirements and performance measurement techniques are employed in the testing.

Lesson 6: JOPES GSPRs need to be fixed concurrent with JOPES business process reengineering.

JOPES has served as a constant source of irritation for the GCCS community. Promised gains from the transition from WWMCCS and subsequent GCCS releases did not materialize; additional problems arose from the transition, including database synchronization, slow system response, breakdowns, and a legion of GSPRs; the JOPES user community is dissatisfied; and too often the health of JOPES has been confused with the health of GCCS. There are two essential problems with JOPES.

The first and most important, is that the processes underlying JOPES are in need of major revision. The way the data are collected, stored, manipulated, and presented is no longer adequate. For example, SORTS takes generic unit data and provides the basis for building a TPFDD (Time Phased Force and Deployment Data). JOPES planners know that these plain vanilla units rarely exist in the real world, yet they are forced to make their plans based on exactly this type of generic data. SORTS should be allowed to compensate for dissimilar unit types. This is but one example of many. These process faults are not an

artifact of GCCS, they were also found under WWMCCS. They have, however, left JOPES increasingly maladapted for current planning conditions.

The second problem is largely a result of the transition to GCCS from WWMCCS. Specifically, hundreds of GSPRs have arisen, and remain unresolved despite repeated releases of new versions of GCCS.[17] A significant number of these are priority one GSPRs, which essentially means that the particular piece of software is incapable of performing its mission, although the net effect of these GSPRs is unclear. Nonetheless, the transition has not been and continues to be an uncomfortable passage.

These twin difficulties need to be addressed in tandem, much as a bleeding patient (GSPRs) must survive long enough to make it into surgery (JOPES Business Process Reengineering). Both areas are making progress, but a concerted effort needs to be made to ensure that the current form of process reengineering doesn't fail as so many past attempts have.

4. Operations and Support

Lesson 7: The GCCS community needs a configuration management system appropriate to facilitate interoperability, security, and manageability in a commercial, client-server environment.

One concern expressed by the community is the lack of configuration management. Configuration management, of which there are many types (e.g., operational, system, technical, etc.) essentially refers to knowing what you have and how it relates to the other pieces in the system. Although modern systems are forgiving in how they are set up, they will be less stable, more vulnerable to attack, more costly, and not run as well, if done without configuration management. Two significant difficulties have been encountered by the GCCS community.

The first is in coordinating the different users, a particularly challenging task in a rapidly evolving distributed computing environment with hundreds of sites and thousands of terminals. Knowledge about any particular site, while clearly known to that site, often appears to be incorrect or absent. Two solutions present themselves. The first solution is to introduce and/or broaden the use of automatic and remote system interrogation programs to define the system, an act which is already happening across a broad swath of the community. The second solution is simply to improve the coordination between the

[17] The definition of what constitutes a GSPR and what level of priority it constitutes is unclear, especially in a distributed computing environment such as GCCS.

field and headquarters, which, based on the interviews in the field, appears to be lacking. Clearly delineating roles and responsibilities would aid in improving this coordination.

A second problem is the introduction of software modifications or new applications at the local level without prior approval and testing by DISA. This potentially leads to security and compatibility problems. This type of practice has bedeviled operators of large networks since their inception, and is not unique to GCCS. Given the unlikelihood of stopping such practices, and the desire to keep the system responsive to unique local needs, ground rules should be established which allow for local modifications within limits proscribed by a central authority, DISA. The Joint Staff should also play a role in ensuring some form of system administration from the center, while retaining local autonomy.

Lesson 8: Additional personnel need to be added to the DISA PM's office.

The ability of the DISA technical program manager for GCCS to manage the program is hampered by staffing problems in the form of unfilled billets and high staff turnover. At the time the PM was interviewed, it was learned that manning was at approximately 50 percent (7 of 14 billets filled). In addition, a high-turnover rate, due in part to military rotation policies, harms the development of institutional expertise and memory.

These facts, coupled with a perception in the community that the PM's office is understaffed, and the recommendation in this report for additional duties to be given to the PM's office, call for an increase in staffing. Although this study does not attempt to quantify the level of additional staffing beyond a placeholder level or two or three additional person-years, it should serve as a basis for the PM's office to review staffing levels and request additional resources as necessary.

Lesson 9: Training needs to be improved.

GCCS training has consistently lagged fielding by many months. This possibly is due in part to the way in which IT technology, and software in particular, is treated, not just by DoD but by society *writ large*. Typically, software is fielded without training, and this is accepted as *normal* practice. How many of us have received the latest Microsoft or Oracle software release, with zero training, yet we are expected to immediately make use of it. Although the more complex the system, the less prevalent this dynamic becomes, it still may affect attitudes towards training, even if subtle.

A second reason training has lagged is that GCCS has not yet developed a community of trained personnel with strong institutional support, as JOPES did. Training is fragmented and/or non-standardized, with different offices teaching different pieces of GCCS, as opposed to the more holistic approach taken by JOPES; classroom training has been criticized as lacking teachers with operational experience or live data feeds, for example; software documentation is absent or inadequate; self-paced and distance learning is largely absent; and the Commander has no ready means of identifying who on the staff has had GCCS training.

To remedy this situation, it is recommended that classroom training be supplemented with distance learning and self-paced learning opportunities. Travel to the classroom is often costly, time consuming, and not reactive to immediate needs. Distance learning is less expensive and quicker, while self-paced training and help features[18] allow the user to proceed at one's own pace. Neither, however, is a substitute for the classroom. In addition, the commander should have the ability to quickly identify who has been trained on GCCS, e.g, a note in the personnel file, a centralized database, etc.

Although beyond the scope of this study, additional thought should be given to creating a central training location/office similar to the JOPES Training Office.

E. CONCLUDING REMARKS

Although the concept of evolutionary acquisition is not new, the Global Command and Control System represents in scope the most significant program to date in which DoD has attempted to implement this approach. It may be fairly termed a success. Major new capabilities have been gained through an acquisition process which has been flexible enough to meet rapidly changing user requirements and to incorporate new technology. On a more cautionary note, however, the perils of having insufficient process were evident in the early days of GCCS. Insufficient process led to inadequate testing, program drift, and still indeterminate costs, among other ills. The pendulum has fortunately once more swung back towards process, although process that is flexible yet substantive. Evolutionary acquisition does not obviate the need for a roadmap, for example, but rather reinforces the need as program and acquisition processes become more flexible. Flexibility without form equals chaos. The managers of future C2 programs would do well to heed the lessons learned by the GCCS community when weighing the merits of a roadmap, a

[18] Examples of self-paced training might include CD-ROMs, manuals, videos, etc. A help feature could be something as simple as a pull-down menu, much as is found in Microsoft applications.

requirements process, configuration management, or other acquisition processes currently under review by the acquisition community.

Appendix A

GLOSSARY

ACC	Air Combat Command
ACOM	Atlantic Command
ACTD	Advanced Concept Technology Demonstration
AFCEA	Armed Forces Communications and Electronics Association
ASD	Assistant Secretary of Defense
BPR	Business Process Reengineering
C2	Command and Control
C3I	Command, Control, Communications, and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
CENTCOM	Central Command
CINC	Commander in Chief
COE	Common Operating Environment
COP	Common Operational Picture
COTS	Commercial Off The Shelf
DARPA	Defense Advanced Research Projects Agency
DART	Dynamic Analysis and Reprogramming Tool
DII	Defense Information Infrastructure
DISA	Defense Information Systems Agency
DoD	Department of Defense
DT	Development Testing
EPIP	Evolutionary Phase Implementation Plan
EUCOM	European Command
FORSCOM	Forces Command
GAO	General Accounting Office
GCCS	Global Command and Control System
GOTS	Government Off The Shelf
GRiD	GCCS Requirements Database
GSPR	GCCS Software Problem Report
IG	Inspector General
ILSP	Integrated Logistics Support Plan

IOC	Initial Operating Capability
IT	Information Technology
JOPES	Joint Operations Planning and Execution System
JS	Joint Staff
JTF	Joint Task Force
MAISRC	Major Automated Information System Review Council
MDT	Modified Development Testing
O&M	Operations and Maintenance
O&S	Operations and Support
OSD	Office of the Secretary of Defense
OT	Operational Testing
PACOM	Pacific Command
PM	Program Manager
PPB	Planning Programming and Budgeting System
RID	Requirements Implementation Document
RWG	Requirements Working Group
SIPRNET	Secret Internet Protocol Router Network
SoR	System of Record
SORTS	Status of Readiness and Training
T&E	Testing and Evaluation
TEMP	Testing and Evaluation Master Plan
TPFDD	Time Phased Force and Deployment Data
TRANSCOM	Transportation Command
USFK	U.S. Forces Korea
WAM	WWMCCS Automated Data Processing Modernization Program
WIS	WWMCCS Information System
WWMCCS	World Wide Military Command and Control System

Appendix B

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13. ABSTRACT (Maximum 200 words)

This paper summarizes a "lessons learned" study that reviews DoD's approach to managing the GCCS program on behalf on the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD/C3I). This study, conducted in the Fall/Winter of 1997-98, provides a brief history of the program. It presents the views of the communities that develop, test, support, or use GCCS, and offers some specific lessons learned for continuing to strengthen the management of the program.

14. SUBJECT TERMS
BPR, Business Process Reengineering, Command and Control, distributed computing, EPIP, Evolutionary Acquisition, Evolutionary Phased Implementation Plan, GCCS, Global Command and Control, Global Command and Control System, Joint Operations Planning and Execution System, JOPES, Requirements Implementation Document, RID, Secret Internet Protocol Router Network, SIPRNET, SOR, System of Record, World-Wide Military Command and Control System, WWMCCS

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